

**AMENDMENTS TO THE CLAIMS:**

The listing of claims will replace all prior versions and listings of claims in the application.

Please cancel claims 6-21.

**LISTING OF THE CLAIMS**

1. (Previously Presented) An intelligent ink cartridge comprising:  
at least one ink chamber for storing ink therein;

an electronics module adapted to store identification information data of the ink cartridge and ink remaining data, the electronics module including a micro-controller with embedded memory storing a program executable to control access and processing of ink remaining data in the ink cartridge to improve the maximum of ink volume of the ink cartridge; and,

a control circuit operatively connected with said micro-controller and defining a preselected time constant value to distinguish between a checking read cycle of said intelligent ink cartridge and a normal read cycle of said intelligent ink cartridge.

2. (Previously Presented) An intelligent ink cartridge according to claim 1, wherein said memory is an EEPROM.

3. (Previously Presented) An intelligent ink cartridge according to claim 1, wherein said micro-controller is an 8-bit CMOS RISC micro-controller.

4. (Previously Presented) An intelligent ink cartridge according to claim 1 wherein said micro-controller includes:

an arithmetic and logic unit connected with a data bus, an EEPROM memory for storing said identification information data of the ink cartridge and said ink remaining data, plural registers, an interrupt unit, a serial periphery interface unit, a timer, an analog comparator, an I/O interface; and,

a program memory connected to said arithmetic and logic unit by said register for storing a program controlling reading and writing operations and calculation of ink remaining data.

5. (Previously Presented) An intelligent ink cartridge comprising:

at least one ink chamber adapted to store ink therein;

an electronics module adapted to store identification information data of the ink cartridge and ink remaining data, the electronics module being a micro-controller with embedded non-volatile memory storing a program executable to control access and processing of ink remaining data in the ink cartridge to improve a maximum of ink volume of the ink cartridge, said micro-controller including:

an arithmetic and logic unit connected with a data bus;

an EEPROM memory for storing said identification information data of the ink cartridge and said ink remaining data, plural registers, an interrupt unit, a serial periphery interface unit, a timer, an analog comparator, an I/O interface; and,

a program memory connected to said arithmetic and logic unit by said register for storing a program controlling reading and writing operations and calculation of ink remaining data; and,

a R-C control circuit defining a preselected time constant value, used to distinguish between a checking read cycle of said cartridge and a normal read cycle of said cartridge, wherein, said R-C control circuit is connected to an input interface of said micro-controller.

6-21. (Cancelled)

22. (Previously Presented) An ink cartridge comprising:

at least one ink chamber adapted to store ink therein;

an electronics module adapted to store identification information data of the ink cartridge and ink remaining data, and;

a control circuit defining a preselected time constant value to distinguish between a checking read cycle of said cartridge and a normal read cycle of said cartridge.

23. (Previously Presented) The ink cartridge according to claim 22, wherein:  
the electronics module includes a micro-controller with embedded memory storing a program executable to control access and processing of said ink remaining data in the ink cartridge to improve an amount of ink volume consumed from the ink cartridge.

24. (Previously Presented) The ink cartridge according to claim 23, wherein:  
said R-C control circuit is connected to an input interface of said micro-controller.

25. (Previously Presented) An ink cartridge according to claim 23, wherein  
said non-volatile memory is an EEPROM.

26. (Previously Presented) An ink cartridge according to claim 23, wherein  
said micro-controller is an 8-bit CMOS RISC micro-controller.

27. (Previously Presented) An ink cartridge according to claim 23, wherein  
said micro-controller includes:

an ALU (arithmetic and logic unit) connected with a data bus;

an EEPROM memory for storing said identification information data of the ink cartridge and said ink remaining data;

plural registers;

an interrupt unit;

a serial periphery interface unit;

a timer;

an analog comparator;

an I/O interface, and,

a program memory portion of said embedded memory connected to said ALU by at

least one of said plurality of registers for storing a program controlling reading and writing operations and a calculation of ink remaining data.

28. (Previously Presented) An ink cartridge according to claim 23, wherein said program is adapted to execute the steps of:

transferring an ink utilization percentage stored in EEPROM to register temp1 in said micro-controller during printer power on or when the ink cartridge is installed on the associated ink jet apparatus and moved to normal position;

transferring said ink utilization percentage into said ink jet apparatus from said register temp1 when a control signal of the associated ink jet apparatus is received;

updating the ink utilization percentage at the associated ink jet apparatus during printing;

storing the updated ink utilization percentage written into the ink cartridge from the associated ink jet apparatus into the register temp2 in said micro-controller during printer power off or when the ink cartridge is moved to installation position;

executing steps in said micro-controller of:

temp3=temp2=temp1;

temp3-temp3/(1+x%), wherein, x% is the targeted increment in ink capacity of said ink cartridge;

temp1=temp1+temp3; and,

storing ink utilization percentage updated to EEPROM from said register temp1 and using it as the output from cartridge to the associated ink jet apparatus for the next printer power on read cycle.

29. (Previously Presented) An ink cartridge according to claim 28, wherein said program is adapted to further execute a check step for checking whether updated ink utilization percentage is larger than predetermined value y, and adjusting the ink utilization percentage if no previous adjustments had been performed wherein x% is the targeted increment in ink capacity and a% is the additional consumption due to an additional head

cleaning operation, so as to check whether ink utilization has been adjusted when ink utilization percentage is higher than  $(x+a)\%$  and the ink utilization is updated, wherein,  $adj=0$  means ink utilization has been not adjusted and  $adj=1$  means ink utilization has been done.

30. (Previously Presented) An ink cartridge according to claim 29, wherein the check step for checking whether said micro-controller has adjusted ink utilization percentage of a new ink cartridge includes:

- setting an initial status flag into EEPROM of a new ink cartridge;
- reading and judging said status flag; and,

- subtracting  $(x+a)$  from the updated ink utilization percentage before storage to EEPROM should the status flag has been not adjusted and updated ink utilization percentage be higher than  $(x+a)\%$ , and change the flag to signify ink utilization percentage had been adjusted.

31. (Previously Presented) An ink cartridge according to claim 29, wherein said program is adapted to further execute an additional check step for distinguishing a first read cycle immediately following a write cycle during printer power off from a second read cycle performed during printer power on.

32. (Previously Presented) The ink cartridge apparatus according to claim 23, wherein said program is executable by said micro-controller for manipulating said ink remaining data for increasing said utilization of ink from the ink cartridge apparatus by:

- transferring ink utilization percentage data stored in a register temp1 in said micro-controller i) during a power on cycle of said associated printing device and ii) when the ink cartridge apparatus is installed on the associated printing device and moved to a normal position;

- transferring the ink utilization percentage data into the associated printing device from register temp1 in response to a control signal received from the

associated printing device is received;

updating the ink utilization percentage data after a printing operation;

storing the ink utilization percentage data written into the ink cartridge apparatus from the associated printing device into a register temp2 in said micro-controller during a power off of said associated printing device or when said ink cartridge apparatus is moved to an installation position relative to said associated printing device;

subtracting the previously stored ink utilization percentage data in register temp1 from the updated ink utilization percentage data in register temp2 and storing the result of said subtracting into a register temp3;

dividing a value  $\text{temp3} = \text{temp2} - \text{temp1}$  obtained in the subtracting step by a divisor  $(1+x\%)$  to generate a quotient value and storing the quotient value in register temp3;

adding the quotient value in register temp3 obtained in said dividing step to said previously stored ink utilization percentage data in register temp1 as  $\text{temp1} = \text{temp3} + \text{temp1}$ ;

storing the value in register temp1 in a memory of said micro-controller; and,

using the value temp1 stored in said register as an output from said ink cartridge apparatus to said associated printing device during a subsequent power on read cycle of said associated printing device.

33. (Previously Presented) The ink cartridge apparatus according to claim 32, wherein said program is executable by said microcontroller for manipulating said ink remaining data for increasing said utilization of ink from the ink cartridge apparatus by:

using a software flag (adj) stored in a memory of said micro-controller on said ink cartridge apparatus to signify whether said ink utilization data had been adjusted by the micro-controller using an initial logical value of "0" to signify an unadjusted state;

transferring said ink utilization data stored in said memory to a register reg1

when receiving a power signal from said associated printing device or when mounting said ink cartridge apparatus during a power on cycle of said associated printing device;

sending said ink utilization data to said associated printing device from reg1 under control of said associated printing device upon a power on cycle of said associated printing device;

permitting a printing operation by said associated printing device;

storing said updated ink utilization data written to said ink cartridge apparatus into register reg1 during a power off cycle of said associated printing device or during a removal of the ink cartridge apparatus from the associated printing device;

transferring, when the value stored in register reg1 is less than a predetermined value y and the logical value of the flag adj is "0", the updated ink utilization percentage data as stored in register reg1 into a predetermined memory location in said micro-controller during a power off cycle of said associated printing device; and,

subtracting, when the logical value stored in register reg1 is less than said predetermined value y and said logical value of the flag adj is "0",  $(x+a)$  from register reg1 and storing the result back to register reg1, where x% is a targeted increment in ink capacity and a% is an additional consumption due to additional head cleaning operations performed by said associated printing device.

34. (Previously Presented) The ink cartridge apparatus according to claim 23, wherein said computer program is executable by said micro-controller for manipulating said ink remaining data for increasing said utilization of ink from the ink cartridge apparatus by:

using a software flag (adj) stored in a memory location in said micro-controller to signify whether said ink utilization data had been adjusted by the micro-controller with an initial logical value of "0" to signify an unadjusted state;

transferring the updated ink utilization data stored in said memory location of said micro-controller to a register reg1 upon a power on cycle of said associated

printing device or upon an installation of said ink cartridge onto said associated printing device;

sending said ink utilization percentage data in register reg1 to said associated printing device upon a power on cycle of said printing device when a one of: i) an external signal TP1 is received by said micro-controller indicating a normal read cycle logic level  $TP1=0$ , ii) when a value stored in register reg1 is less than a predetermined value y, and iii) when said ink utilization percentage data had been modified as determined based on the value of the software flag adj being a logic level 1 value;

subtracting  $(x+a)$  from register reg1 and storing the result in register reg1 when i) said software flag adj has a logic value of "0", ii) the value stored in register reg1 is greater than said predetermined value y, and iii) the external signal TP1 received indicates a checking read cycle logic level  $TP1=1$  and changing said software flag adj to a logic level of "1" and sending the value in reg1 to the associated printing device upon a power on cycle where x% is a targeted increment in ink capacity and a% is an additional consumption due to an additional head cleaning operation in said associated printing device;

permitting a printing operation in said associated printing device;

storing the updating ink utilization percentage data written to said micro-controller from said associated printing device to register reg1 upon a power off cycle of said associated printing device or upon a moving of said ink cartridge apparatus to an installation position for removal relative to said associated printing device; and,

updating the ink utilization percentage data stored in a memory of said micro-controller with the value stored in register reg1.

35. (Previously Presented) The ink cartridge according to claim 23, wherein said program stored in said memory of the micro-controller is configured to manipulate said ink remaining data for increasing a utilization of ink from the ink cartridge.

36. (Previously Presented) The intelligent ink cartridge according to claim 5, wherein said program is adapted to execute the steps of:

transferring an ink utilization percentage stored in EEPROM to register temp1 in said micro-controller during printer power on or when the ink cartridge is installed on the associated ink jet apparatus and moved to normal position;

transferring said ink utilization percentage into said ink jet apparatus from said register temp1 when a control signal of the associated ink jet apparatus is received;

updating the ink utilization percentage at the associated ink jet apparatus during printing;

storing the updated ink utilization percentage written into the ink cartridge from the associated ink jet apparatus into the register temp2 in said micro-controller during printer power off or when the ink cartridge is moved to installation position;

executing steps in said micro-controller of:

temp3=temp2=temp1;

temp3=temp3/(1+x%), wherein, x% is the targeted increment in ink capacity of said ink cartridge;

temp1=temp1+temp3; and,

storing ink utilization percentage updated to EEPROM from said register temp1 and using it as the output from cartridge to the associated ink jet apparatus for the next printer power on read cycle.

37. (Previously Presented) The intelligent ink cartridge according to claim 36, wherein said program is adapted to further execute a check step for checking whether updated ink utilization percentage is larger than predetermined value y, and adjusting the ink utilization percentage if no previous adjustments had been performed wherein x% is the targeted increment in ink capacity and a% is the additional consumption due to an additional head cleaning operation, so as to check whether ink utilization has been adjusted when ink utilization percentage is higher than (x+a)% and the ink utilization is updated,

wherein,  $\text{adj}=0$  means ink utilization has been not adjusted and  $\text{adj}=1$  means ink utilization has been done.

38. (Previously Presented) The intelligent ink cartridge according to claim 37, wherein the check step for checking whether said micro-controller has adjusted ink utilization percentage of a new ink cartridge includes:

setting an initial status flag into EEPROM of a new ink cartridge;

reading and judging said status flag; and,

subtracting  $(x+a)$  from the updated ink utilization percentage before storage to EEPROM should the status flag has been not adjusted and updated ink utilization percentage be higher than  $(x+a)\%$ , and change the flag to signify ink utilization percentage had been adjusted.

39. (Previously Presented) The intelligent ink cartridge according to claim 37, wherein said program is adapted to further execute an additional check step for distinguishing a first read cycle immediately following a write cycle during printer power off from a second read cycle performed during printer power on.

40. (Previously Presented) The ink cartridge apparatus according to claim 5, wherein said program is executable by said micro-controller for manipulating said ink remaining data for increasing said utilization of ink from the ink cartridge apparatus by:

transferring ink utilization percentage data stored in a register temp1 in said micro-controller i) during a power on cycle of said associated printing device and ii) when the ink cartridge apparatus is installed on the associated printing device and moved to a normal position;

transferring the ink utilization percentage data into the associated printing device from register temp1 in response to a control signal received from the associated printing device is received;

updating the ink utilization percentage data after a printing operation;

storing the ink utilization percentage data written into the ink cartridge apparatus from the associated printing device into a register temp2 in said micro-controller during a power off of said associated printing device or when said ink cartridge apparatus is moved to an installation position relative to said associated printing device;

subtracting the previously stored ink utilization percentage data in register temp1 from the updated ink utilization percentage data in register temp2 and storing the result of said subtracting into a register temp3;

dividing a value  $\text{temp3} = \text{temp2} - \text{temp1}$  obtained in the subtracting step by a divisor  $(1+x\%)$  to generate a quotient value and storing the quotient value in register temp3;

adding the quotient value in register temp3 obtained in said dividing step to said previously stored ink utilization percentage data in register temp1 as  $\text{temp1} = \text{temp3} + \text{temp1}$ ;

storing the value in register temp1 in a memory of said micro-controller; and,

using the value temp1 stored in said register as an output from said ink cartridge apparatus to said associated printing device during a subsequent power on read cycle of said associated printing device.

41. (Previously Presented) The ink cartridge apparatus according to claim 5, wherein said program is executable by said microcontroller for manipulating said ink remaining data for increasing said utilization of ink from the ink cartridge apparatus by:

using a software flag (adj) stored in a memory of said micro-controller on said ink cartridge apparatus to signify whether said ink utilization data had been adjusted by the micro-controller using an initial logical value of "0" to signify an unadjusted state;

transferring said ink utilization data stored in said memory to a register reg1 when receiving a power signal from said associated printing device or when mounting said ink cartridge apparatus during a power on cycle of said associated

printing device;

sending said ink utilization data to said associated printing device from reg1 under control of said associated printing device upon a power on cycle of said associated printing device;

permitting a printing operation by said associated printing device;

storing said updated ink utilization data written to said ink cartridge apparatus into register reg1 during a power off cycle of said associated printing device or during a removal of the ink cartridge apparatus from the associated printing device;

transferring, when the value stored in register reg1 is less than a predetermined value y and the logical value of the flag adj is "0", the updated ink utilization percentage data as stored in register reg1 into a predetermined memory location in said micro-controller during a power off cycle of said associated printing device; and,

subtracting, when the logical value stored in register reg1 is less than said predetermined value y and said logical value of the flag adj is "0",  $(x+a)$  from register reg1 and storing the result back to register reg1, where x% is a targeted increment in ink capacity and a% is an additional consumption due to additional head cleaning operations performed by said associated printing device.

42. (Previously Presented) The ink cartridge apparatus according to claim 5, wherein said program is executable by said micro-controller for manipulating said ink remaining data for increasing said utilization of ink from the ink cartridge apparatus by:

using a software flag (adj) stored in a memory location in said micro-controller to signify whether said ink utilization data had been adjusted by the micro-controller with an initial logical value of "0" to signify an unadjusted state;

transferring the updated ink utilization data stored in said memory location of said micro-controller to a register reg1 upon a power on cycle of said associated printing device or upon an installation of said ink cartridge onto said associated printing device;

sending said ink utilization percentage data in register reg1 to said associated printing device upon a power on cycle of said printing device when a one of: i) an external signal TP1 is received by said micro-controller indicating a normal read cycle logic level TP1=0, ii) when a value stored in register reg1 is less than a predetermined value y, and iii) when said ink utilization percentage data had been modified as determined based on the value of the software flag adj being a logic level 1 value;

subtracting  $(x+a)$  from register reg1 and storing the result in register reg1 when i) said software flag adj has a logic value of "0", ii) the value stored in register reg1 is greater than said predetermined value y, and iii) the external signal TP1 received indicates a checking read cycle logic level TP1=1 and changing said software flag adj to a logic level of "1" and sending the value in reg1 to the associated printing device upon a power on cycle where x% is a targeted increment in ink capacity and a% is an additional consumption due to an additional head cleaning operation in said associated printing device;

permitting a printing operation in said associated printing device;

storing the updating ink utilization percentage data written to said micro-controller from said associated printing device to register reg1 upon a power off cycle of said associated printing device or upon a moving of said ink cartridge apparatus to an installation position for removal relative to said associated printing device; and,

updating the ink utilization percentage data stored in a memory of said micro-controller with the value stored in register reg1.

43. (Previously Presented) The intelligent ink cartridge according to claim 5, wherein said program improves said maximum of ink volume in said cartridge by manipulating said ink remaining data to increase a utilization of ink consumed from the ink cartridge.